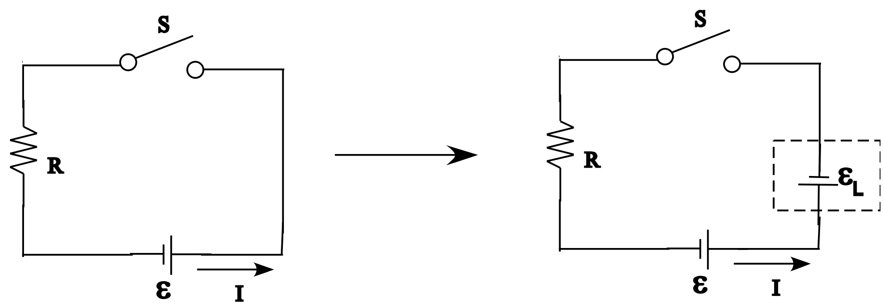
SELF-INDUCTANCE

Consider the following circuit:



A. When the switch is closed the current does not reach its max value of I = ε/R instantaneously. Faraday's Law can be used to explain why this occurs.
B. When the switch is closed the current increases and the magnetic flux throught the circuit increases.
C. This increase in flux induces an EMF such that it would cause an induced current that would oppose the increase in flux through the circuit.
D. Such induced EMF would have to be opposite to ε.
E. The result is a gradual increase of the current rather than an instantaneous increase.
F. This effect is called self-induction because the self-induced EMF arises from the circuit itself.

ε_L = self-induced EMF (back - emf)

The flux through the loop is proportional to the current in the loop:

(1) $$N\Phi_B = LI$$

Where the proportionality constant *L* is called the self-inductance.

$$\boxed{L = \frac{N\Phi_B}{I}}$$ Self-Inductance

Differentiating (1) $N\Phi_B = LI$ gives:

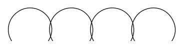
$$N\frac{d\Phi_B}{dt} = L\frac{dI}{dt}$$

$$\boxed{\varepsilon_L = -L\frac{dI}{dt}}$$ self-induced EMF

The negative sign is due to Lenz's Law which states that the induced EMF in a circuit opposes any change in the current in the circuit.

Properties of Inductance

1. Since $L = -\frac{\varepsilon_L}{dI/dt}$, inductance is a measure of the opposition to a change in current .
2. The purpose of an inductor is to oppose any variations in the current through a circuit.
3. Circuits element that have large self-inductances are called inductors. Ex. Solenoids



4. The current through an inductor cannot change instantaneously.
5. The SI unit of inductance is the Henry (H)
   1H = 1 V.s/A